



SOIL HEALTH IN THE FACE OF GLOBAL CHANGE

Maribeth Rubenstein

For Jane Lucas, springtime signals the start of a new growing season. She spends her time digging in the dirt and keeping tabs on how well plants are growing in an old hayfield. Lucas is not a farmer, she's an ecologist, but her work aims to help farmers anticipate and adapt to global change.

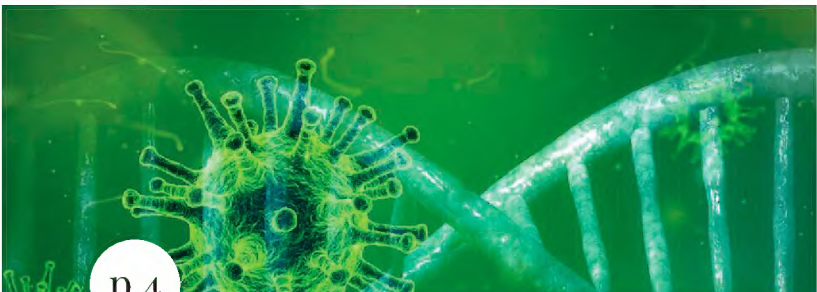
In 80 experimental plots, Lucas is studying how a variety of factors affect soil health. Called Stressed Out Soils, the 10-year project will reveal strategies to help maintain healthy soils and maximize soil carbon storage in the rapidly changing Hudson Valley and beyond.

Factors stressing out our soils include rising temperatures, drought, antibiotics from wastewater and cow manure, and fungicides, often used to protect crops. Stressed Out Soils is testing 16 combinations of these stressors, to see how they interact. Until now, they have primarily been studied one at a time.

On some of the plots, plexiglass enclosures block wind and trap heat. Partial coverings funnel away some rain, simulating drier conditions. Select plots get treated with antibiotics and fungicides. Some are exposed to only one of these stressors. Others are hit with two, three, or four stressors at once.

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FROM OUR PRESIDENT



Dear Friends,

Cary Institute science informs and guides environmental solutions in a changing world. Our expertise has never been more crucial: climate change, urbanization, pollution, and other drivers of global change are increasing at an unprecedented rate, with serious impacts to people, nature, and natural resources.

As we move into our fifth decade, some policy makers scorn science when convenient to do so, and the broad, societal embrace of science has weakened. Yet, I remain optimistic about the pivotal role of science and Cary's leadership in achieving a more sustainable future. New tools — from AI to drones, to remote and automated environmental sensors, to advanced genomics, to more powerful modeling

approaches — help us predict pandemics (p. 4), understand soil health (p. 1), and manage forests and freshwater resources (pp. 4, 8). Cary science underpins sound decision making and human well being.

Our new strategic plan, now in draft, will guide us through 2030. Central to this plan is growing the Cary research community — adding core scientists, postdocs, and distinguished visitors from a diversity of disciplines. We also committed to increasing our Science Innovation Funds (p. 7). Supported by donors, these Funds are essential for kick-starting high-risk, high-reward projects, mapping out new scientific frontiers, leveraging larger grants, and powering publications, conferences, and collaborations.

None of this is possible without our friends and donors, so thank you for your support and for your interest in our important work.

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Since the project kicked off in the summer of 2022, Lucas and her team have been rigorously collecting data, including how much CO₂ the soil microbes are exhaling — a measure of how stressed out they are.

Preliminary results have been counterintuitive. For plots with only one type of stressor, the fungicide, drought, and warming treatments each decreased the amount of CO₂ coming off of plots — likely meaning they had lower microbial activity compared to control plots. Bactericidal plots, on the other hand, were giving off more CO₂.

A huge question in the soil science world is: How much more carbon can we store in soil?

But when bactericide was combined with warming, CO₂ production was much higher than in the controls. “They’re not canceling each other out,” Lucas explains. “They’re coming together to magnify an effect.”

And while warming, drought, and fungicide alone each decreased CO₂ production, when you put them all together, they increase the amount of CO₂ production.

“The big take-home point is that these treatments are not following a consistent additive pattern,” she says. Still, she cautions, it will be several years before the team can pick out reliable trends in the data.

The team is also tracking how the different treatments affect the diversity of plants, microbes, fungi, and invertebrates within the plots. In addition, Lucas has plans to incorporate insecticides as a stressor.

This summer, she looks forward to running an experiment that will reveal how the stressors affect the ecosystem’s ability to absorb excess carbon. “A huge question in the soil science world is: How much more carbon can we store in soil?” says Lucas. “Knowing the capacity of your soils and how past stress might be affecting that capacity is going to be a key question to answer, and we will start to get at that.”

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Cary’s research possible.**

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Marist College students visiting the plots. The fieldwork site acts as a living classroom where farmers and students learn about soil health.

THREATS TO SOIL HEALTH



WHAT CAN YOU DO?

Compost and decrease food waste.

Keep land covered with deep-rooted plants, cover crops, or mulch.

Rotate crops in your garden and incorporate compost.

Opt for more deep-rooting lawns in line with grasses native to your region.

Reduce lawn chemicals.

Make choices that reduce your climate footprint.



Pam Freeman

LEVERAGING ARTIFICIAL INTELLIGENCE TO PREVENT PANDEMICS

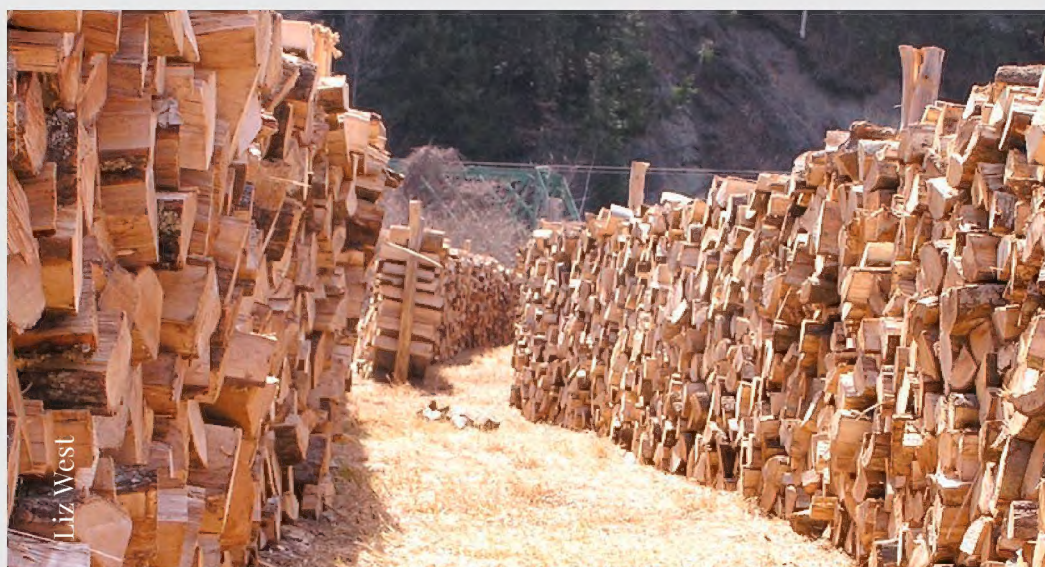
Disease ecologist Barbara Han is on a mission to overhaul the way we handle pandemics. Instead of scrambling to catch up after an outbreak has already started, her work pushes the paradigm toward prediction and prevention.

Han uses artificial intelligence to investigate the who, what, where, when, and why of virus spillover. Her two newest projects demonstrate how AI can be an essential tool to forecast which variants pose

the biggest threat to people, and under which conditions they are most likely to emerge.

With \$3 million from the U.S. Department of Agriculture, Han is co-leading a study that will employ AI to identify future variants of SARS-CoV-2, the virus that causes COVID-19. By flagging variants that could be problematic if they emerge in wildlife, the project will generate a surveillance watch-list for the public health community.

IN NORTHEASTERN FORESTS, CURRENT LOGGING PRACTICES MAY BE THE BEST CLIMATE SOLUTION



Liz West

What role should wood play in generating electricity? Unlike fossil fuels, wood is renewable. Burning it releases greenhouse gases, but the emissions could theoretically balance out as new trees grow and absorb carbon.

In reality, calculating the net benefits or costs of forest biomass energy is complicated, and depends on many factors — including rates of forest productivity and carbon sequestration, alternative uses for wood products, and what types of fuels are displaced by wood.

Cary Institute's Charlie Canham recently co-authored one of the most thorough accountings to date on how increased logging would impact

“That way, if we find one of these variants in the wild, we’ll know that we should sit up and pay attention,” says Han.

Together with experts at IBM Research, the project will develop a novel AI trained on the structures of past harmful COVID strains, generating a list of future strains that may be able to spread between people and animals. Another tailor-made AI will identify potential animal hosts for each strain by hypothesizing which species have cell receptors that are susceptible to each variant.

The AI’s educated guesses will then be tested on cells in petri dishes, taking pieces of the predicted strains and verifying whether they could actually infect the predicted animal hosts. The results will be used to further refine the AI conjectures and watchlist.

When viral loads and contact with humans are high, that signals a potential for the virus to jump into humans.

Drawing on 30 years of environmental monitoring at Cary Institute, the team will also simulate a Northeastern forest to understand how SARS-CoV-2 moves through ecosystems where many species are differentially susceptible to infection.

While this study examines the who, what, and

where, another new project is investigating when outbreaks occur. At field sites in the UK and Uganda, Han and an international team of collaborators will monitor how changing seasons, land use, and human behavior influence viral outbreaks in wild rodent populations, to identify hotspots with high potential for spillover into people. The project is supported by \$2.9 million in funding from the National Science Foundation and \$1.9 million from the UK’s Biotechnology and Biological Sciences Research Council.

The project involves trapping rodents to see which viruses they’re carrying, at what levels, and how that changes over time. When viral loads and contact with humans are high, that signals a potential for the virus to jump into humans.

Ecological equations can model how various factors interact to influence virus abundance and spillover risk, but Han will use existing AI techniques to speed up the process and cast a wider net.

“AI gives us a powerful way to use theory to explore these dynamics across thousands of species all at once,” she says. “It can also reveal patterns that you might otherwise not be able to see.”

Together, the two projects will inform disease surveillance efforts, helping to spot emerging diseases before they turn into pandemics, and guiding strategies to reduce spillover risk.

carbon budgets in New York, Vermont, New Hampshire, and Maine.

The scientists modeled the impacts of several different harvesting scenarios. One represented ‘business as usual,’ where timber harvesting continues at current levels. Others assessed various combinations of increased harvest intensity, harvest frequency, and proportion of timber harvest dedicated to biofuel.

The study’s main strength, Canham says, is that it more precisely simulates how logging happens in real life. Most logging companies take a few logs and leave some trees standing, rather than clearcutting large swaths of forest. This practice hadn’t been captured in previous models.

The team’s conclusion: increasing timber harvests to feed biomass power plants actually increases overall greenhouse gas emissions, by reducing forest carbon storage more than it displaces fossil fuel emissions.

“We see no potential for large-scale forest biomass energy to contribute to a carbon neutral future for the Northeastern region,” says Canham.

However, homeowners who heat with wood stoves need not fret. At the household scale, Canham estimates that wood stoves may still be a sustainable option. “I’m not giving up my wood stove,” he says.

BULLETIN BOARD

Opportunities,
announcements,
and events

Staff Awards & Distinctions



Stuart Findlay

Recipient

Spirit of the Hudson Award



Congratulations to Stuart, who is being honored by Hudson River Sloop Clearwater for his 30+ years of work dedicated to the recovery of

Peter Groffman

2025 President-elect

Ecological Society of America



Peter is the 5th Cary scientist to take the helm of ESA — the nation's largest organization of professional ecologists. Congratulations, Peter!

Intern Spotlight



Nafisa Rashid
Education Intern

This position has given me the opportunity to provide support to Cary youth programs that I participated in as a student years ago. It has allowed me to learn about the behind-the-scenes of science education programming!

This spring, Nafisa has been helping to manage data resources and organize the Hudson Data Jam Competition — an annual competition where students develop a creative project that tells a science story about the Hudson Valley.

UPCOMING

Ecology Walk: Spongy Moth

Sat. June 8 @1pm

An interpretive walk led by terrestrial ecologist Clive Jones.

caryinstitute.org/events

VIDEO

The Spongy Moth in Our Yards and Forests

Discover how outbreaks start and whether you should be concerned about their impact in your area.

caryinstitute.org/lecture-videos

VIDEO

Caught on Camera

Watch clips of wildlife on our campus and learn about animal behavior. Includes tips on using trail cams on your property.

caryinstitute.org/lecture-videos

Ecofocus is published by Cary Institute of Ecosystem Studies, an independent nonprofit center for environmental research. Since 1983, our scientists have been investigating the complex interactions that govern the natural world and the impacts of climate change on these systems. Our findings lead to more effective management and policy actions and increased environmental literacy. Staff are global experts in the ecology of: cities, disease, forests, and freshwater.

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OUR THANKS

SCIENCE INNOVATION FUNDS

Fueling innovative, risk-taking research

Some ideas are too bold and boundary-pushing to be funded through traditional pathways. Cary's Science Innovation Funds fill this gap.

The Funds have kick-started major initiatives to shape sustainable cities, forecast disease, and more. But there is much more work to do. We're looking to dramatically scale up the Funds in the coming years.

Support science that drives discovery and inspires world-changing solutions. To make a gift to one of the existing Funds, or to establish your own, contact Catherine at 845-677-7600 x262 or forbesc@caryinstitute.org



FUNDED

Envisioning Future Forests

Science Innovation Funds are allowing our scientists to investigate why a quarter of Alaska's forests aren't bouncing back after wildfires.



"It gives me a thrill to know that by supporting the Science Innovation Funds, I personally give Cary's scientists the chance to test out novel ideas that other sources of funding would almost certainly consider a risky investment."

Once off the ground, those 'risky' ideas then very often garner traditional funding for an array of succeeding projects — something that is yet another wonderful reward for investing in the kind of innovative science Cary promotes."

- Bindy Kaye



Martin L. Senzel's Legacy

Marty served in leadership on Cary's Board of Trustees for 12 years providing sagacious counsel, unflagging support of our work, and a wonderful, dry sense of humor. His death on January 28 came too soon, just after he completed his fourth board term.

Marty's gifts to the Institute were so many: his time, insights, and generous financial support. We are deeply honored that he named Cary in his will for a legacy gift, reminding us of his enduring commitment to making the world a better place. His wife, Dagni, also named the Institute in his obituary, and we want to thank her, and everyone who made a gift in Marty's memory.



BECOME A MEMBER OF THE MARY FLAGLER CARY LEGACY SOCIETY

Establish your legacy while sustaining science for the future of our planet.

If you'd like more information or to join the Mary Flagler Cary Legacy Society, contact Catherine at 845-677-7600 x262 or forbesc@caryinstitute.org



BEWARE OF TICKS WHEN OUTDOORS

Stay safe when enjoying our trails this season

- Tuck pants into socks to prevent ticks from crawling onto your bare legs
- Use insect repellent
- Stay on the trails; ticks are more abundant in brush and leaf litter
- Check yourself for ticks
- Shower after hiking

LAKE TROUT RESEARCH INFORMS NEW ADIRONDACK NATURE PRESERVE



Follensby Pond, Harrietstown, New York

Research by Cary ecologist Chris Solomon has informed a recent decision to protect 14,600 acres in the Adirondacks. The agreement between New York State and The Nature Conservancy establishes a research preserve around Follensby Pond, where Solomon studied lake trout a decade ago.

Follensby Pond is an almost pristine wilderness area, surrounded by wetlands and healthy forests. Its water is cold and deep, and — unlike 95% of Adirondack lakes — it's expected to stay that way, providing crucial cold-water habitat in a hotter future.

Solomon's research provided the only population estimates of Follensby's unusual heritage lake trout, highlighting their vulnerability to overexploitation.

"Populations like Follensby's — where the fish are abundant and grow to large sizes — don't exist in many places anymore," says Solomon. "Because they grow slowly and mature late, it's too easy to fish them down."

Getting a clearer picture of the population size and structure allowed Solomon's team to assess the costs and benefits of various fishing management strategies. Findings informed The Nature Conservancy's decision not to allow any fishing at Follensby Pond.

"The lake trout assessment demonstrated that public access would basically eradicate what has been termed an 'old growth' population of a species that is particularly vulnerable to climate change," says Dirk Bryant of The Nature Conservancy. "Those findings, combined with other research, highlighted both the opportunity and need to protect the lake and surrounding watershed."